A JOURNAL OF THE AMERICAN DIABETES ASSOCIATION



EDITOR IN CHIEF

Martin G. Myers Jr., MD, PhD

SENIOR ASSOCIATE EDITORS

David A. D'Alessio, MD

Maureen A. Gannon, PhD

Randy J. Seeley, PhD

ASSOCIATE EDITORS

Charles F. Burant, MD, PhD Alessandro Doria, MD, PhD

Maria B. Grant, MD, FARVO William H. Herman, MD, MPH

Kevan C. Herold, MD

Jeffrey F. Horowitz, PhD

Jiandie D. Lin, PhD

Carey Nien-Kai Lumeng, MD, PhD

Laurie J. Goodyear, PhD

Struan F.A. Grant, PhD

Pedro L. Herrera, PhD

Young-Bum Kim, PhD

Sheldon E. Litwin, MD

Aaron W. Michels, MD

Bettina Mittendorfer, PhD

Daniel J. Moore, MD, PhD

David P. Olson, MD, PhD

Edwards A. Park, PhD

Linda R. Peterson, MD

Nicolas Musi, MD

Erik Näslund, PhD

Francis C. Lynn, PhD

James D. Johnson, PhD

Richard G. Kibbey, MD, PhD

James L. Kirkland, MD, PhD

Patrick E. MacDonald, PhD

Kieren J. Mather, MD, FRCPC

Franck Mauvais-Jarvis, MD, PhD

Viswanathan Mohan, MD, FRCP, PhD, DSc,

FNASc, FASc, FNA, FACP, FACE, FTWAS

Eric Hajduch, PhD

Alyssa Hasty, PhD

Jeonga Kim, PhD

Rodica Pop-Busui, MD, PhD

Leslie Satin, PhD

Doris A. Stoffers, MD, PhD

Morris F. White, PhD

EDITORIAL BOARD

Steven F. Abcouwer, PhD Reza Abdi, MD

Gail K. Adler, MD, PhD, FAHA

Laura C. Alonso, MD David A. Antonetti, PhD

Alan D. Attie, PhD

Julio E. Ayala, PhD

Bryan C. Bergman, PhD

Shawn C. Burgess, PhD

Lu Cai, MD, PhD

Nigel A. Calcutt, PhD

Jonathon Campbell, PhD

Gregory Cooney, PhD

Daniel J. Drucker, MD

Josephine M. Egan, MD,

MRCPI, FRCPI

Gian Paolo Fadini, MD, PhD

Brian N. Finck, PhD

Simon J. Fisher, MD, PhD

Alessia Fornoni, MD, PhD

Patrick Fueger, PhD

Richard E. Gilbert, MBBS, PhD,

FRCPC

Benjamin Glaser, MD

Bret H. Goodpaster, PhD

Ormond A. MacDougald, PhD

Massimo Pietropaolo, MD

Alberto Pugliese, MD

Matthew Rodeheffer, PhD

Michael Roden, MD

Liangyou Rui, PhD

Guy A. Rutter, PhD

Alice S. Ryan, PhD

Darleen Sandoval, PhD

Gary J. Schwartz, PhD

Masakazu Shiota, DVM, PhD

Kevin R. Short, PhD

Show-Ling Shyng, PhD

Scott Soleimanpour, MD Andreas Stahl, PhD

Jacqueline M. Stephens, BS, PhD

Craig S. Stump, MD, PhD,

FACE

Gianna Maria Toffolo, PhD

Michael I. Trenell, PhD

Vincenzo Trischitta, MD

Hubert M. Tse, PhD

Matthias von Herrath, MD

Matthew Watt, PhD

Li Wen, MD, PhD

Jianping Ye, MD

Lori M. Zeltser, PhD

AMERICAN DIABETES ASSOCIATION OFFICERS

CHAIR OF THE BOARD

David A. DeMarco, PhD

PRESIDENT, MEDICINE & SCIENCE

Alvin C. Powers, MD

PRESIDENT, HEALTH CARE & EDUCATION

Brenda Montgomery, RN, MSHS, CDE

SECRETARY/TREASURER

Umesh Verma

CHAIR OF THE BOARD-ELECT Jeffrey Himmel, MS

PRESIDENT-ELECT, MEDICINE & SCIENCE

Jane Reusch, MD

PRESIDENT-ELECT, HEALTH CARE & EDUCATION

Felicia Hill-Briggs, PhD, ABPP

SECRETARY/TREASURER-ELECT

Michael Ching, CPA

CHIEF EXECUTIVE OFFICER

Kevin L. Hagan

INTERIM CHIEF SCIENTIFIC & MEDICAL OFFICER

Tamara Darsow, PhD



A JOURNAL OF THE AMERICAN DIABETES ASSOCIATION



Mission Statement for **Diabetes**

Diabetes publishes original research about the physiology and pathophysiology of diabetes mellitus. Submitted manuscripts can report any aspect of laboratory, animal, or human research. Emphasis is on investigative reports focusing on areas such as the pathogenesis of diabetes and its complications, normal and pathological pancreatic islet function and intermediary metabolism, pharmacological mechanisms of drug and hormone action, and biochemical and molecular aspects of normal and abnormal biological processes. Studies in the areas of diabetes education or the application of accepted therapeutic and diagnostic approaches to patients with diabetes are not published. More information about the journal can be found online at diabetes.diabetesjournals.org.

Copyright © 2017 by the American Diabetes Association, Inc. All rights reserved. Printed in the USA. Requests for permission to reuse content should be sent to Copyright Clearance Center at www.copyright.com or 222 Rosewood Dr., Danvers, MA 01923; phone: (978) 750-8400; fax: (978) 646-8600. Requests for permission to translate should be sent to Permissions Editor, American Diabetes Association, at permissions@diabetes.org.

The American Diabetes Association reserves the right to reject any advertisement for any reason, which need not be disclosed to the party submitting the advertisement.

Commercial reprint orders should be directed to Sheridan Content Services, (800) 635-7181, ext. 8065.

Single issues of *Diabetes* can be ordered by calling toll-free (800) 232-3472, 8:30 A.M. to 5:00 P.M. EST, Monday through Friday. Outside the United States, call (703) 549-1500. Rates: \$75 in the United States, \$95 in Canada and Mexico, and \$125 for all other countries.

PRINT ISSN 0012-1797 ONLINE ISSN 1939-327X PRINTED IN THE USA Diabetes is available online at diabetes.diabetesjournals.org. Please call the numbers listed above, e-mail membership@diabetes.org, or visit the online journal for more information about submitting manuscripts, publication charges, ordering reprints, subscribing to the journal, becoming an ADA member, advertising, permission to reuse content, and the journal's publication policies.

Periodicals postage paid at Arlington, VA, and additional mailing offices.

AMERICAN DIABETES ASSOCIATION PERSONNEL AND CONTACTS

VICE PRESIDENT, PUBLISHER Michael Eisenstein

ASSOCIATE PUBLISHER, SCHOLARLY JOURNALS Christian S. Kohler

EDITORIAL OFFICE DIRECTOR Lyn Reynolds

PEER REVIEW MANAGER
Jane Castner

EDITORIAL ASSISTANT Joan Garrett

DIRECTOR, SCHOLARLY JOURNALS Heather Norton Blackburn

CONTENT PRODUCTION MANAGER

Kelly Newton

EDITORIAL CONTENT MANAGER

Oedipa Rice

TECHNICAL EDITOR
Theresa Cooper

ASSOCIATE DIRECTOR, BILLING & COLLECTIONS Laurie Ann Hall

DIRECTOR, MEMBERSHIP/ SUBSCRIPTION SERVICES Donald Crowl

SENIOR ADVERTISING MANAGER Julie DeVoss Graff jdevoss@diabetes.org (703) 299-5511 ADVERTISING REPRESENTATIVES

AMERICAN DIABETES ASSOCIATION
Paul Nalbandian
Associate Publisher, Advertising &
Sponsorships
pnalbandian@diabetes.org
(703) 549-1500, ext. 4806

Tina Auletta Senior Account Executive tauletta@diabetes.org (703) 549-1500, ext. 4809

PHARMACEUTICAL/DEVICE DIGITAL ADVERTISING e-Healthcare Solutions John Burke Chief Revenue Officer sales@ehsmail.com (609) 882-8887, ext. 149